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ORIGINAL

PROVISIONAL SPECIFICATION FOR AN INVENTION ENTITLED

Invention Title: **TEMPERATURE CONTROL METHOD AND APPARATUS**

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The invention is described in the following statement :

This invention relates to a temperature control method and apparatus applicable to dies and to moulding of articles using dies in processes such as injection moulding, thermoforming, vacuum forming and the like.

The invention will be described with respect to an application but it is not intended that the concept should be constrained simply to that application.

It is well known that a die being used for moulding plastics products can be kept within an acceptable temperature range by use of water passing through the die to a separate heat exchange station.

In such an arrangement then, water is pumped through the die through appropriate passages within the die and one of the challenges in the design of dies is to ensure that there can be sufficient access to cooling water to keep the temperature of the effective parts within an acceptable range.

Such a challenge of keeping a die cool is no small matter and can involve considerable costs in the manufacturing and commissioning. Existing cooling methods use a flow of cooling water. Unless the water is degassed and demineralised which is generally uneconomic because of the volume of replacement water needed , then corrosion and scale build up will occur which again can be costly to treat and can lead to reduced efficiency in cooling over time.

The above comments are simply to indicate the type of problems currently experienced.

It is an object of this invention to propose an alternative way to effect temperature control of a die.

In one form of this invention then, although this need necessarily be the only or indeed the broadest form of this, there is proposed an arrangement to effect a control of temperature of a die including an enclosed chamber for liquid together with substantially only the vapour of the liquid within the chamber, a wall of the chamber below an upper level of the liquid within the chamber being adapted to transmit heat from a targeted location of the die into the liquid within the chamber, and heat exchange means located within the

chamber but above a level of liquid within the chamber and adapted by reason of heat exchange to effect condensation of vapour within the area of the chamber above the liquid level.

The concept then is to have substantially the vapour only of the liquid within an area within a closed chamber located above a liquid surface.

This can be achieved for instance by fully filling the chamber with a selected liquid and then evacuating from the chamber only some of this liquid to leave an area above a liquid level within the chamber allowing therefore the liquid to provide its own vapour to fill the space in the chamber above the liquid level.

In this way then, the pressure within the chamber is determined by the vapour pressure available from the liquid itself.

In use then condensation of the vapour may be effected by providing a heat exchange either by an independent member within the space above the liquid level or by having a portion or all of the wall defining the chamber in an area above the liquid surface which is at a lesser temperature but in any event, so that there will be a reasonably effective exchange of heat from the vapour of the liquid so that this then condenses back into liquid and will flow back into the body of the liquid within the closed chamber.

The portion of the chamber to receive heat will, by reason of a raised temperature of the immediately adjacent liquid to above that of the liquid in adjacent areas, effect an exchange of state of the liquid in this area to vapour which by reason of the latent heat capacity of the vapour will be a very efficient carrier of heat.

By reason of relative densities then, the vapour thus formed will rise to the surface of the liquid, continuing to fill the space above the liquid where continuing condensation is being effected by a reverse exchange of heat.

What we have then is a closed chamber with its selected liquid operating so that it is at a temperature and pressure governed by its own vapour pressure and by external inputs of heat.

In preference, such an arrangement is provided as a mould for moulding of articles were the portion of the die directly connecting with the moulding portion, is a portion of the die located adjacent liquid within a closed chamber within the die.

A number of variation can be incorporated within the general concept.

In a first method, the internal chamber is filled with the liquid to be used. In preference, such liquid is previously treated so as to remove dissolved gases and other unnecessary materials so that in preference, the liquid is a pure liquid without impurities which may otherwise interfere with the process or the efficiency in general of the process.

Once full and sealed, the chamber is then accessed through a one way valve so that some of the liquid is then extracted with a pump to a level that is chosen such that the level will be below a condensation member or means within the upper part of the chamber, and that there will be liquid in contact with heat source which is to provide the heat to be dissipated.

Following these steps, the die is then ready to be used where there is a heat exchanger in an upper part of the internal chamber to provide heat exchange where a further liquid is pumped through the heat exchanger at a preferred mould or die operating temperature but in preference not a low enough temperature to cause freezing of the liquid.

It is expected at this stage that the liquid would normally be water but it is understood that there are many liquids other than water that would provide a good effect.

For each individual circumstance, the degree of heat to be shifted, the extent of the hot surfaces to be cooled, and the general temperature that has to be worked on, need to be considered to take into account the overall dimensions of the chamber, the fluid to be used, the degree of vapour space above the liquid level, and the condensing means within the vapour space.

In calculations so far, such an arrangement will provide very significant improvements in terms of effective heat transfer and will allow much more efficient heat transfer to be effected.

In a preferred further feature, there can also be provided a heating means to be located within the chamber within the liquid such that during a standby time, the temperature of the die or mould can be kept within a selected range.

While reference has been made to a chamber, this does not of itself exclude the case where there can be separate bodies connected by sealed conduits.

A chamber then is to be considered as a concept broad enough to encompass any closed environment.

For a further explanation of the invention this will be described with reference to a further embodiment which shall be described with reference to an accompanying drawing wherein

Fig 1 is a schematic cross sectional view of a thermoforming apparatus in accord with the invention.

Referring in detail to the drawing there is shown a thermoforming apparatus 1 with a plug 2 arranged to push plastic sheet into a shaping cavity 3. The sheet 4 is subject to conventional treatment including having air at pressure drive the formed sheet 4 into close conforming shape of the cavity 3.

The cavity 3 is surrounded by a hollow body 5 which defines a closed chamber together with conduits 6 and 7 and condensing container 8.

Within the condensing container 8 is a heat exchange coil 9 which is supplied with appropriate cooling refrigerant.

Conduit 7 passes beneath drive spocket 13 and therefore could cause a liquid blockage to passage of vapour through to the condensing container 8.

This effect can be removed by introducing additional heat through heating coil 11 which will effect a vapourisation of the liquid at this location..

Initial startup of this apparatus is acheived by filling the chamber which includes the hollow body 5, the conduits 6 and 7 and the container 8 with degassed and demineralised water. Using the valve 12 and plug 14 all air is initially extracted and then using a one way connection the liquid is then

extracted to have this lowered to a level as shown at 15. This then leaves an upper evacuated space 16 which will then be filled implicitly by substantially the vapour of the liquid.

From here on the arrangement will remain as a closed system so that heat from the wall of the cavity 3 will be absorbed into latent heat of vaporisation with the vapour reaching the condensing chamber to be returned to liquid.

Throughout this specification the purpose has been to illustrate the invention and not to limit this.

Dated this 11th day of June 1998

MALCOLM BARRY JAMES
By his Patent Attorneys,
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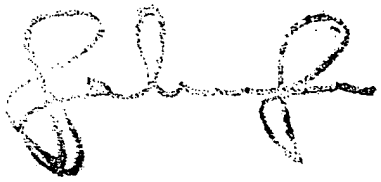

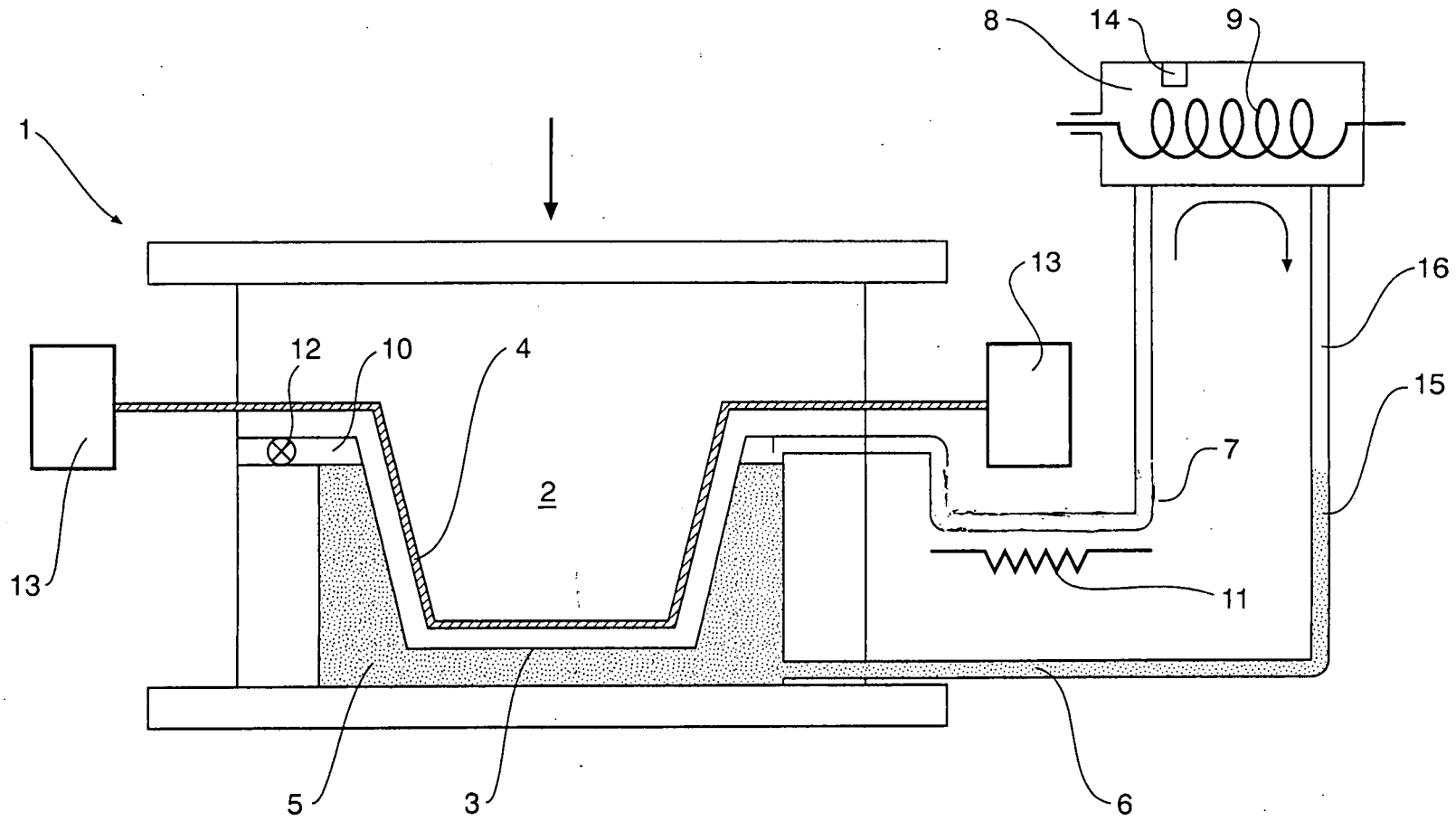

FIG 1